## REMARKS

This Amendment is responsive to the Office Action mailed on August 21, 2002. A petition for a 1-month extension of time is attached so that the due date for responding to the Office Action is extended to December 21, 2002. Entry of the Amendment is respectfully requested.

In this Amendment, claims 1-5 are canceled, and claims 6-20 are added, so that claims 6-20 are pending and subject to examination on the merits.

Support for new claims 6-20 can be found throughout the specification, claims, and drawings as originally filed. For example, exemplary support can be found as follows: 6 (claim 4, spec. ¶¶ 14-15), 7 (spec. ¶ 15), 8 (spec. ¶ 26), 9 (spec. ¶ 16), 10 (spec. ¶ 20), 11 (spec. ¶¶ 16-17), 12 (spec. ¶ 18), 13 (spec. ¶¶ 14-16), 14 (spec. ¶ 15), 15 (spec. ¶ 26), 16 (spec. ¶ 19), 17 (spec. ¶ 20), 18 (spec. ¶ 15), 19 (spec. ¶¶ 20-21), and 20 (spec. ¶ 18). No new matter is added.

The Office Action contains a number of objections and rejections. Each objection and rejection will be addressed in the order presented in the Office Action.

### Double Patenting

On page 2 of the Office Action, the Examiner rejects claim 1, because it is a duplicate of claim 12 in U.S. Patent Application No. 09/976,927.

In response, claim 1 is canceled. Withdrawal of the rejection is requested.

### Information Disclosure Statement

On page 3 of the Office Action, the Examiner states that the listing of the references in the specification is not a proper information disclosure statement. The citations in the specification are not a formal information disclosure statement. An information disclosure statement was filed on July 10, 2002. Withdrawal of the objection is requested.

Applicants note that a copy of the Form PTO/SB/08B submitted with the July 10, 2002 information disclosure statement (considered by the Examiner) did not accompany the Office Action. Applicants request that a copy of the Form PTO/SB/08B be initialed by the examiner and returned to Applicants with the next Office Action.

US Patent Nos. 5,079,600 ("Schnur '600") and 5,389,496 ("Calvert '496")

Claims 1-5 are rejected as anticipated by Schnur '600. Schnur '600 discloses a self-assembling film and a catalytic precursor for an electroless plating bath (see abstract). Claims 1-5 are also rejected as anticipated by Calvert '496. Each rejection is traversed.

Neither reference anticipates any of claims 6-20. "For a prior art reference to anticipate in terms of 35 U.S.C. §102, every element of the claimed invention must be identically shown in a single reference." *In re Bond*, 15 USPQ2d 1566, 1567 (Fed. Cir. 1990). Here, each and every element is not taught by the cited references so the anticipation rejection is improper. For example, neither Schnur '600 nor Calvert '496 teach or suggest a "diffusion barrier".

With respect to Schnur '600, the Examiner states that "[i]t is seen to be inherent that the 'thin film' is a diffusion barrier, because it is the same thin film as disclosed and claimed by Applicant, and because the 'metal' is on the 'thin film' and is not shown in Schnur to diffuse through it, thereby meeting Applicant's definition of 'diffusion barrier'". With respect to Calvert '496, the Examiner states "it is seen to be inherent that the covalently bonded 'chemical groups' or 'catalyst ligating groups' of Calvert inherently form a self-assembled monolayer which serves as a diffusion barrier for the reasons indicated above in reference to Schnur."

These allegations of inherency are insufficient to establish that Schnur '600 or Calvert '496 anticipate the pending claims. "To establish inherency, the extrinsic evidence 'must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency, however, may not be established by probabilities or

possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient.'". *In re Robertson*, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999). "In relying upon the theory of inherency, the examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic necessarily flows from the teachings of the applied prior art." *Ex parte Levy*, 17 USPQ2d 1461, 1464 (Bd. Pat. App. & Inter. 1990). There is no basis for assuming that a "diffusion barrier" is inherent in Schnur '600 or Calvert '496.

Schnur '600 teaches a self-assembling film and a catalytic precursor for electroless plating (abstract). Schnur '600 fails to mention that his self-assembled film can function as a "diffusion barrier" and further fails to provide any testing that shows that his self-assembling film can prevent diffusion between, for example, silicon and copper. There is nothing in Schnur '600 that suggests that the described catalytic precursor would *necessarily* be a diffusion barrier. Accordingly, there is no basis for assuming that Schnur '600 teaches a "diffusion barrier" and the anticipation rejection based on Schnur '600 is improper for this reason alone. Calvert '496 also suffers from these deficiencies.

The deposition of copper (or other metals), to the extent that it is described in Schnur '600 or Calvert '496, does not cause diffusion. High temperatures and/or electrical fields cause diffusion. The examples in the present application to demonstrate diffusion barrier effectiveness when devices are subjected to high temperature and electric fields. If the examples in the present application did not have the diffusion barrier, copper would have diffused through the oxide under the copper.

In support of Applicants' argument that embodiments of the invention are not inherent in Schnur '600 or Calvert '496, Applicants submit herewith the Declaration Pursuant to 37 CFR 1.132 of Dr. Shyam P. Murarka ("the Murarka Declaration"), a co-inventor in the present application. In the Murarka Declaration, Dr. Murarka, an inventor with many years of experience in the field, states at paragraph 6 of the Murarka Declaration that:

> Contrary to the assumption in the rejections based on Schnur '600 and Calvert '496, I do not believe that either reference "inherently" discloses a "diffusion barrier". Neither Schnur '600 nor Calvert '496 describe or suggest self-assembled monolayers that are diffusion barriers. For example, neither Schnur '600 nor Calvert '496 tested their structures like the present inventors to show that copper diffusion does not occur under conditions such as thermal bias annealing. Consequently, I do not believe that the inventions defined by claims 6-20, each of which recites a "diffusion barrier", in the Amendment are "inherent" in Schnur '600 or Calvert '496.

As Applicants have submitted evidence of non-inherency and the Examiner has provided no evidence of inherency, Applicants request that the anticipation rejections (which is based on inherency) be withdrawn.

Although the Applicants do not agree with the anticipation rejections, Applicants have canceled claims 1-5 and are submitting new claims 6-20 in an effort to expedite the prosecution. Independent claim 6 recites a diffusion barrier including a SAM with molecules, wherein "each molecule [has] an aromatic group at the terminus of the molecule." Independent claim 12 also recites a diffusion barrier including a SAM with molecules, each molecule having "an aromatic group at the terminus of the molecule."

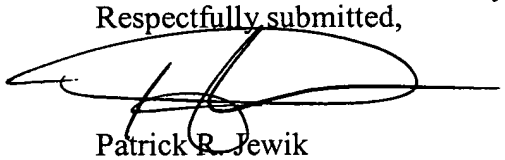
The present inventors have discovered that self-assembled monolayers (SAMs) with molecules with longer chains and aromatic terminal groups are better at preventing diffusion than SAMs with molecules having shorter chains and aliphatic terminal groups. See FIG. 3 in the present application and the associated discussion in the specification. Neither Schnur '600 nor Calvert '496 recognized that SAMs with molecules with longer chains and aromatic terminal groups are better at preventing diffusion that SAMs with molecules having shorter chains and aliphatic terminal groups. See, paragraph 7 of the Murarka Declaration. There is certainly no teaching, suggestion, or recognition by Schnur '600 or Calvert '496 that molecules having longer chains and aromatic terminal groups are especially useful as diffusion barriers. Accordingly, claims 6-20 are clearly patentable over the cited art.

## CONCLUSION

In view of the foregoing, Applicants believe all claims now pending in this Application are in condition for allowance. The issuance of a formal Notice of Allowance at an early date is respectfully requested.

If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned at 415-576-0200.

Respectfully submitted,



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## VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Claims 1-5 are canceled.

The following claims are added.

6. (New) A semiconductor device comprising:

(a) a substrate;

(b) a diffusion barrier, wherein the diffusion barrier comprises a self-assembled monolayer including a plurality of molecules, each molecule having an aromatic group at the terminus of the molecule; and

(c) a metal layer on the diffusion barrier.

7. (New) The semiconductor device of claim 6 wherein the substrate comprises silicon oxide on silicon and the metal layer comprises copper.

8. (New) The semiconductor device of claim 6 wherein each molecule comprises a linear carbon chain having at least 2 carbon atoms.

9. (New) The semiconductor device of claim 6 wherein the metal layer is a formed by a vapor deposition process.

10. (New) The semiconductor device of claim 6 wherein the diffusion barrier is capable of preventing the diffusion of metal atoms from the metal layer into the substrate when the semiconductor device is exposed to thermal annealing at 200 °C or an electric field of 2 MV/cm at 200 °C in flowing $N_2$.

11. (New) The semiconductor device of claim 6 wherein the diffusion barrier coats the walls of a hole in the substrate and wherein the metal layer fills the hole.

12. (New) The semiconductor device of claim 6 wherein the metal layer is in direct contact with the terminal groups of the molecules in self-assembled monolayer.

13. (New) A semiconductor device comprising:

(a) a semiconductor substrate;

(b) a diffusion barrier, wherein the diffusion barrier comprises a self-assembled monolayer including a plurality of molecules, each molecule having a linear chain at least two atoms long, and an aromatic group at the terminus of the molecule; and

(c) a metal layer on the diffusion barrier, wherein the metal layer is formed by a vapor deposition process.

14. (New) The semiconductor device of claim 13 wherein the substrate comprises silicon oxide on silicon and the metal layer comprises copper.

15. (New) The semiconductor device of claim 13 wherein each molecule comprises a linear carbon chain having at least 2 carbon atoms.

16. (New) The semiconductor device of claim 13 wherein the metal layer is formed by a sputtering process.

17. (New) The semiconductor device of claim 13 wherein the diffusion barrier is capable of preventing the diffusion of metal atoms from the metal layer into the substrate when the semiconductor device is exposed to thermal annealing at 200 °C or an electric field of 2 MV/cm at 200 °C in flowing $N_2$.

18. (New) The semiconductor device of claim 13 wherein the substrate comprises silicon oxide on silicon.

19. (New) The semiconductor device of claim 13 wherein the device does not exhibit $j_{leakage} > 1000\ nAcm^{-2}$ when the semiconductor device is exposed to thermal annealing at 200 °C or an electric field of 2 MV/cm in flowing $N_2$ at 200 °C for up to 650 minutes.

20. (New) The semiconductor device of claim 13 wherein the metal layer is in direct contact with the terminal groups of the molecules in self-assembled monolayer.